Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE 100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

A REPORT TO
SHINING HILL ESTATES OPERATOR INC.

A GEOTECHNICAL INVESTIGATION FOR PROPOSED SCHOOL BLOCK

SHINING HILL PHASE 3
306 ST. JOHN'S SIDEROAD

TOWN OF AURORA

REFERENCE NO. 2008-S135B

JANUARY 2021

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TABLE OF CONTENTS

TABLES

ENCLOSURES

1.0 INTRODUCTION

In accordance with the written authorization dated September 17, 2020 from Mr. Paul Bailey of Shining Hill Estates Operator Inc., a geotechnical investigation was carried out at 306 St. John's Sideroad, in the Town of Aurora.

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for the design and construction of a proposed school block. The geotechnical findings and resulting recommendations are presented in this report.

2.0 SITE AND PROJECT DESCRIPTION

The Town of Aurora is situated on Schomberg Lake (glacial) plain where drift has been partly eroded and filled with lacustrine clay, silt, sand and reworked till.

The subject site is located on the north side of St. John's Sideroad, slightly west of Yonge Street, in the Town of Aurora, and borders the Town of Newmarket to the north. At the time of the investigation, a building was located within the central portion of the site, with the surrounding area being grass-covered with some landscaping. Driveways were located within the east portion of the property, and leading upto the main house entrance. The ground surface at the site was relatively flat.

It is understood that the site will be converted into a private school block, which will be provided with municipal services and roadways meeting urban standards.

3.0 FIELD WORK

The field work, consisting of 6 boreholes to depths of 6.6 to 35.3 m, was performed between September 15 and 21, 2020, at the locations shown on the Borehole Location Plan, Drawing No. 1.

The boreholes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed "List of Abbreviations and Terms", were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or 'N' values) of the subsoil. The relative density of the granular strata and the consistency of the cohesive strata are inferred from the 'N' values. Split-spoon samples were recovered for soil classification and laboratory testing. The field work was supervised and the findings were recorded by a Geotechnical Technician.

Upon completion of borehole drilling and sampling, 4 groundwater monitoring wells were installed at 3 borehole locations including 1 set of nested wells, to facilitate a hydrogeological assessment by others. The remaining boreholes were backfilled to the ground surface using bentonite holeplug and auger cuttings.

The borehole location was surveyed using a handheld Global Navigation Satellite System (Trimble Geoexplorer 6000 series) equipment, and the ground surface elevation was then interpolated from the topographic survey prepared by Lloyd & Purcell, and provided by SCS Consulting Group Inc.

4.0 SUBSURFACE CONDITIONS

The investigation has disclosed that beneath a topsoil or topsoil fill layer in places, and/or a layer of earth fill, the site is underlain by strata of silty clay, sand, silt, sandy silt, silty fine sand and/or silty sand till at various locations and depths.

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 6, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2, and the engineering properties of the disclosed soils are discussed herein.

4.1 **Topsoil** (Boreholes 201, 202, 203 and 206) and **Topsoil Fill** (Borehole 204)

The revealed topsoil layer is approximately 10 to 23 cm thick. In addition, a layer of topsoil fill to a depth of 0.8 m from the prevailing ground surface was encountered at Borehole 204. The topsoils are dark brown in colour, indicating appreciable amounts of roots and humus which are compressible under loads; they should be removed for site development. In order to prevent overstripping, diligent control of the stripping operation will be required.

The topsoils will generate an offensive odour and may produce volatile gases under anaerobic conditions. They can only be reused for general landscaping purposes, but they must not be buried below any structures or deeper than 1.2 m below the exterior finished grade so they will not have an adverse impact on the environmental well-being of the developed area.

4.2 **Earth Fill** (Boreholes 201, 202, 203 and 205)

The earth fill was encountered beneath the topsoil in places, or at the ground surface at Borehole 205, and extends to depths of 0.8± to 3.3± m below the prevailing ground surface; it consists of silty sand, silty clay, sandy silt and/or sand, with varying amounts of gravel, and contains topsoil/organic inclusions in places. At Borehole 205, the fill within the top 1.5± m is mixed with topsoil.

The obtained 'N' values range from 6 to 35, with a median of 9 blows per 30 cm of penetration, indicating the earth fill was loosely placed, and has since self-consolidated in places.

The natural water content of the samples were determined and the results are plotted on the Borehole Logs; the values range from 7% to 23%, with a median of 14%, indicating that the earth fill is in a damp to very moist condition.

Due to the unknown history of the earth fill, and the presence of topsoil and other organic inclusions in places, the fill is unsuitable for supporting any structures in its current condition. In using the fill for structural backfill, or in pavement or slab-on-grade construction, it must be subexcavated, inspected, sorted free of organic inclusions and any other deleterious materials, aerated and properly compacted in thin lifts. If it is impractical to sort the deleterious materials from the fill, the fill must be wasted and replaced with properly compacted inorganic earth fill.

The fill is amorphous in structure; it will ravel and is susceptible to collapse in steep cuts, particularly if the fill is in a wet condition.

One must be aware that the samples retrieved from boreholes 10 cm in diameter may not be truly representative of the geotechnical and environmental quality of the fill, and do not indicate whether the topsoil beneath the earth fill was completely stripped. This should be further assessed by laboratory testing and/or test pits.

4.3 **Silty Clay** (All Boreholes except Borehole 202)

The silty clay was largely encountered in the mid to lower zone of the soil stratigraphy except at Borehole 201 where it was encountered in the upper layer beneath the earth fill; the clay extends to the maximum investigated depth at most boreholes. The silty clay contains a trace to some sand with silt and sand layers in places and occasional gravel. In addition, the clay is mostly varved, where the soils consist of layers of silty clay and silt, making it difficult to delineate. The laminated structure shows that the silty clay is a lacustrine deposit. Grain size analyses were performed on 3 representative samples of the silty clay; the results are plotted on Figure 7.

The obtained ‘N’ values range from 5 blows per 30 cm of penetration to 50 per 5 cm, with a median of 9 per 30 cm, indicating that the consistency of the clay is firm to hard, being generally stiff.

The Atterberg Limits of 2 representative silty clay samples, and the water content of all of the clay samples, were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	33% and 47%
Plastic Limit	19% and 23%
Natural Water Content	11% to 32% (median 22%)

The above results and sample examinations show that the clay has medium plasticity. The natural water content ranges from below the plastic limits to the liquid limits, but generally lies close to the plastic limit, confirming the generally stiff consistency of the clay as disclosed by the ‘N’ values, as well as the presence of silt layers.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility, high soil-adfreezing potential and low water erodibilty.
- Low permeability, with an estimated coefficient of permeability of 10^{-7} cm/sec, an estimated percolation time of more than 80 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive-frictional soil, its shear strength is derived from consistency and augmented by internal friction of the silt. Its strength is moisture dependent and, to a lesser degree, dependent on the soil density.
- It will generally be stable in a relatively steep cut. However, prolonged exposure will allow infiltrating precipitation to saturate the sand and silt seams and layers; this may lead to localized sloughing.
- A very poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 3% or less.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 2500 to 3000 ohm·cm.

4.4 **Sand** (All Boreholes, except Borehole 205)

The sand deposit, ranging from fine to coarse grained at varying locations and depths, was encountered in the upper to mid zone of the revealed soil stratigraphy. The sand contains a trace to some silt with gravel in places. The sorted structure shows that the sand is a glaciolacustrine deposit.

The obtained ‘N’ values range from 5 blows per 30 cm of penetration to 50 per 0 cm, with a median of 34 per 30 cm, indicating the relative density of the sand is loose to very dense, being generally dense. The high ‘N’ value is likely resulted from a cobble in the sand.

The natural water content of the sand was determined and the results are plotted on the Borehole Logs; the values range from 2% to 15%, with a median of 5%, indicating dry to wet, generally damp conditions; the wet sand is water bearing.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- Low to medium frost susceptibility.
- High water erodibility; susceptible to migration through small openings under seepage pressure.
- Pervious, with an estimated coefficient of permeability of 10^{-2} to 10^{-3} cm/sec, an estimated percolation time of less than 5 to 10 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.04
2% - 6%	0.09
6% +	0.13

- A frictional soil, its shear strength is derived from internal friction and is soil density dependent.
- In excavation, the sand will slough, run with seepage and boil under a piezometric head of 0.3 m.
- A fair to pavement-supportive material, with an estimated CBR value of 8% to 10%.
- Moderately low to low corrosivity to buried metal, with an estimated electrical resistivity of 6000 to 6500 ohm·cm.

4.5 **Silt** (Boreholes 202 and 205), **Sandy Silt** (Boreholes 201, 203 and 204) and **Silty Fine Sand** (Borehole 202)

Layers of silt, sandy silt and/or silty fine sand were contacted at various locations and depths; they contain a trace to some clay with occasional gravel in places. The sorted structure indicates that the soils are glaciolacustrine deposits. Grain size analyses were performed on 2 representative samples of the silt and 1 representative sandy silt sample; the results are plotted on Figures 8 and 9.

The obtained 'N' values for the silt range from 10 to 16, with a median of 13 blows per 30 cm of penetration, and the obtained 'N' values for the sandy silt range from 18 to 50, with a median of 22 per 30 cm, while the obtained 'N' value for the silty fine sand is 14 per 30 cm. This indicates that the relative density of the silts and silty fine sand is loose to dense, being generally compact.

The natural water content of the soil samples are plotted on the Borehole Logs; the values range from 11% to 22%, with a median of 17%, indicating moist to wet, generally wet conditions. The samples displayed dilatancy when wetted and shaken by hand.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility and high soil-adfreezing potential.
- High water erodibility; they are susceptible to migration through small openings under seepage pressure.
- Soils of high capillarity and water retention capacity.
- Pervious to relatively low permeability, depending on the clay content, with an estimated coefficient of permeability of 10^{-3} to 10^{-5} cm/sec, an estimated percolation time of 15 to 40 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.04 to 0.11
2% - 6%	0.09 to 0.16
6% +	0.13 to 0.23

- Frictional soils, their shear strength is derived from internal friction and is soil density dependent. Due to their dilatancy, the strength of the saturated silts and silty fine sand is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction of shear strength.
- In excavation, the silts and silty fine sand will slough in steep slopes, run slowly with water seepage, and boil under a piezometric head of 0.4 m.
- Poor pavement-supportive materials, with an estimated CBR value of 3% to 5%.
- Moderate to moderately low corrosivity to buried metal, with an estimated electrical resistivity of 4000 to 5000 ohm·cm.

4.6 **Silty Sand Till** (Borehole 203)

The silty sand till was contacted beneath the earth fill and overlaying sand at one location. The till consists of a random mixture of soils; the particle sizes range from clay to gravel, with the sand fraction exerting the dominant influence on its soil properties, and contains occasional sand seams and layers, cobbles and boulders. The till is heterogeneous and amorphous, showing it is a glacial deposit which has been partially reworked by the past glaciation.

The obtained 'N' values are 29 and 30 blows per 30 cm of penetration, indicating the relative density of the silty sand till is compact.

The natural water content of the silty sand till samples was determined and the results are plotted on the Borehole Log; the values are 6%, 12% and 18%, indicating moist to wet conditions, becoming wet with depth.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility and moderately low water erodibility.
- Relatively pervious, with an estimated coefficient of permeability of 10^{-3} to 10^{-4} cm/sec, an estimated percolation rate of 30 to 40 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.04 to 0.07
2% - 6%	0.09 to 0.12
6% +	0.13 to 0.18

- A frictional soil, its shear strength is primarily derived from the internal friction and is augmented by cementation.
- In steep cuts, the till will be relatively stable; however, under prolonged exposure, localized sheet collapse may occur in the zone where sand and silt layers are prevalent.
- A fair pavement-supportive material, with an estimated CBR value of 10%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4500 to 5000 ohm·cm.

4.7 **Compaction Characteristics of the Revealed Soils**

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	7 to 23 (median 14)	12 to 15	8 to 20
Silty Clay	11 to 32 (median 22)	16 to 20	12 to 25
Silt/Sandy Silt/Silty Fine Sand	11 to 22 (median 17)	12 to 13	8 to 17
Sand	2 to 15 (median 5)	9 to 11	5 to 16
Silty Sand Till	6, 12 and 18	10	6 to 15

The above values show that most of the in situ soils are generally suitable for a 95% or + Standard Proctor compaction. However, portions of the earth fill, clay, silts, silty fine sand and silty sand till are too wet and may require aeration or mixing with drier soils prior to structural compaction. Aeration can be achieved by spreading the wet soil thinly on the ground in the dry and warm weather. In addition, a portion of the earth fill and sand is too dry and will require the addition of water prior to structural compaction. The earth fill and any weathered soils must be sorted free of organic inclusions and any deleterious material prior to structural compaction.

The fill, clay and till should be compacted using a heavy-weight, kneading-type roller. The silts and sands can be compacted by a smooth roller with or without vibration, depending on the moisture content of the soils being compacted. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

One should be aware that with considerable effort, a 90%± Standard Proctor compaction of the wet silts and sands is achievable. Further densification is prevented by the pore pressure induced by the compactive effort; however, large random voids will have been expelled and, with time, the pore pressure will dissipate and the percentage of compaction will increase. There are many cases on record where after a few months of rest, the density of the compacted mantle had increased to over 95% of its maximum Standard Proctor dry density (SPDD).

If the compaction of the soils is carried out with the water content within the range for 95% SPDD but on the wet side of the optimum, the surface of the compacted soil mantle will roll under the dynamic compactive load. This is unsuitable for road construction since each component of the pavement structure is to be placed under dynamic conditions which will induce the rolling action of the subgrade surface and cause structural failure of the new pavement. The slab-on-grade, foundations or bedding of the underground services will be placed on a subgrade which will not be subjected to impact loads. Therefore, the structurally compacted soil mantle with the water content on the wet side or dry side of the optimum will provide adequate subgrade strength for the project construction.

The presence of boulders in the till will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of boulders over 15 cm in size is mixed with the material, it must either be sorted or must not be used for structural backfill and/or construction of engineered fill.

5.0 **GROUNDWATER CONDITIONS**

The boreholes were checked for the presence of groundwater and the occurrence of cave-in upon their completion. The groundwater data are plotted on the Borehole Logs and summarized in Table 2.

Upon completion of borehole drilling and sampling, 4 groundwater monitoring wells were installed at 3 selected borehole locations (Boreholes 201, 205 and 206) to facilitate a hydrogeological assessment by others, which will be presented under a separate cover; a pair of nested wells were installed at the location of Borehole 206. Groundwater levels were recorded in the wells on September 29, 2020 by our office, separate from the hydrogeological assessment and prior to any site visit for groundwater monitoring by the hydrogeological consultant; these water levels are also recorded on the Borehole Logs and summarized in Table 2, and were recorded prior to well development/purging.

Table 2 - Groundwater Levels

Borehole No.	Ground El. (m)	Borehole Depth (m)	Well Depth (m)	Measured Groundwater Level/ Cave-in* On Completion		Measured Groundwater Level in Wells on September 29, 2020	
				Depth (m)	El. (m)	Depth (m)	El. (m)
201	271.9	6.6	-	4.3*	267.6*	-	-
202 (MW)	271.3	6.6	6.1	Dry	-	4.6	266.7
203	272.4	8.1	-	5.2*	267.2*	-	-
204	272.6	35.3	-	N/A**	-	-	-
205 (MW)	274.1	6.6	6.1	Dry	-	3.8	270.3
206D (MW)	273.3	12.6	12.2	Dry	-	2.0	271.3
206S (MW)	273.3	7.6	7.6	Dry	-	3.9	269.4

* Cave-in level (In wet sand and silt layers, the level may represent the groundwater at the time of investigation.)

** No water level measurement taken since borehole was drilled using wash boring

As shown above, no groundwater was recorded in the boreholes on completion, although 2 of the boreholes caved at depths of 4.3± m and 5.2± m from the prevailing ground surface. At Borehole 204, water was added to aid in the drilling operation; therefore groundwater level was unable to be recorded. At Boreholes 202, 205 and 206, wells were installed, with a nested pair installed at Borehole 206, as previously mentioned. Groundwater was recorded at depths of 2.0 to 4.6 m below the prevailing ground surface in the wells on September 29, 2020; however, the groundwater condition of the site and its seasonal fluctuation should be confirmed through the hydrogeological assessment.

In excavation, groundwater yield from the silty clay is expected to be slow in rate and limited in quantity due to its low permeability, while the yield from the silts, sands and silty sand till may be moderate to appreciable, and likely persistent.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath a topsoil or topsoil fill layer in places, and/or a layer of earth fill, the site is underlain by strata of firm to hard, generally stiff silty clay; loose to very dense, generally dense sand; loose to dense, generally compact silt, sandy silt and/or silty fine sand; and/or compact silty sand till at various locations and depths.

Upon completion of the field work, the boreholes remained dry and 2 boreholes caved at depths of 4.3± m and 5.2± m below the prevailing ground surface. In addition, 4 groundwater monitoring wells were installed at 3 borehole locations, with a nested pair installed at Borehole 206. Groundwater in the wells on September 29, 2020 was recorded at depths of 2.0 to 4.6 m below the existing grade. However, these groundwater levels were recorded by our office prior to well development/purging, and should be confirmed through the hydrogeological assessment; the groundwater is subject to seasonal fluctuation.

The proposed redevelopment of this site will consist of a private school block. Although no site plans were available at the time of this report preparation, it is understood that detailed recommendations for the school block may be provided by another consultant, and this report provides general recommendations for the development. The geotechnical findings which warrant special consideration are presented below:

1. The topsoil is unsuitable for engineering applications and must be removed for site development. It can be reused for general landscaping purposes, but it must not be buried below any structures or deeper than 1.2 m below the exterior finished grade so it will not have an adverse impact on the environmental well-being of the developed area.
2. The earth fill is unsuitable for supporting any structures in its current condition. In using the fill for structural backfill, or in pavement of slab-on-grade construction, it should be subexcavated, inspected, sorted free of organic inclusions and any deleterious materials, aerated and properly recompacted in thin lifts. If it is impractical to sort the deleterious material from the fill, the fill must be wasted and replaced with properly compacted inorganic earth fill.
3. The native soils are suitable for light structures on conventional footings. The footing subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that its condition is compatible with the design of the foundation.
4. If the site has to be regraded for development, it is more economical to place an engineered fill for conventional footings, underground services and pavement construction. The weathered soils should be subexcavated and upgraded to engineered fill status by aeration and proper compaction.
5. Excavation should be carried out in accordance with Ontario Regulation 213/91.

The recommendations appropriate for the project described in Section 2.0 are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should subsurface variances become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

6.1 Site Preparation

After removal of topsoil, and/or any structures that are to be demolished/removed for site redevelopment, the site can be pregraded for development. Where earth fill is required to raise the site, it is generally more economical to place an engineered fill for construction. The engineering requirements for a certifiable fill for pavement construction, municipal services, slab-on-grade, and house footings are presented below:

1. The topsoil must be removed, and the subgrade must be inspected and proof-rolled prior to any fill placement.
2. The earth fill and any weathered soil must be subexcavated, sorted free of topsoil inclusions and other deleterious materials, if any, aerated and properly compacted.
3. Inorganic soils must be used for the engineered fill, and they must be uniformly compacted in lifts, 20 cm thick, to 98% or + of their maximum SPDD up to the proposed finished grade and/or slab-on-grade subgrade. The soil moisture must be properly controlled near the optimum. If the foundations are to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% of the maximum SPDD.
4. If the engineered fill is compacted with the moisture content on the wet side of the optimum, the underground services and pavement construction should not being until the pore pressure within the fill mantle has completely dissipated. This must be further assessed at the time of the engineered fill construction.
5. If imported fill is to be used, it should be inorganic soils, free of any deleterious material with environmental issue (contamination). Any potential imported earth fill from off site must be reviewed for geotechnical and environmental quality by the appropriate personnel as authorized by the developer or agency, before it is hauled to the site.
6. The engineered fill must not be placed during the period from late November to early April, when freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
7. If the engineered fill is to be left over the winter months, adequate earth cover, or equivalent, must be provided for protection against frost action.
8. Where fill is to be placed on a bank steeper than 3 horizontal (H):1 vertical (V), the face of the bank must flattened to 3+H:1V so that it is suitable for safe operation of the compactor and the required compaction can be obtained.
9. Where the ground is wet due to subsurface water seepage, an appropriate subdrain scheme must be implemented prior to the fill placement, particularly if it is to be carried out on sloping ground.
10. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.

11. The engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented by qualified surveyors.
12. Foundations partially on engineered fill must be reinforced and designed by a structural engineer to properly distribute the stress induced by the abrupt differential settlement (estimated to be 15± mm) between the natural soils and engineered fill.
13. The footing and underground services subgrade must be inspected by the geotechnical consulting firm that inspected the engineered fill placement. This is to ensure that the foundations are placed within the engineered fill envelope, and the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.
14. Any excavation carried out in certified engineered fill must be reported to the geotechnical consultant who inspected the fill placement in order to document the locations of the excavation and/or to inspect reinstatement of the excavated areas to engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.
15. Despite stringent control in the placement of the engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the foundations must be properly reinforced and designed by the structural engineer for the project. The total and differential settlements of 25 mm and 20 mm, respectively, should be considered in the designed of foundations founded on engineered fill. In sewer construction, the engineered fill is considered to have the same structural proficiency as a natural inorganic soil.

6.2 **Foundations**

For school construction, it is recommended that conventional footings be placed below the earth fill and weathered soil onto the sound natural soils below depths of 1.0 to 2.5 m from the existing ground surface, depending on location and fill depth encountered in the area. The recommended bearing pressures for the design of conventional spread and strip footings are provided below:

- Maximum Soil Bearing Pressure at Serviceability Limit State (SLS) = 100 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State (ULS) = 160 kPa

Below depths of 7.0 m from the existing grade, the soils become weaker with depth; therefore, below this depth, the recommended bearing pressures for the design of conventional spread and strip footings are reduced to the following:

- Maximum Soil Bearing Pressure at Serviceability Limit State (SLS) = 75 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State (ULS) = 120 kPa

The existing earth fill and weathered soil can be subexcavated and replaced with engineered fill suitable for conventional footing construction. Furthermore, where fill is required to raise the grade, or it extended footings and/or cut and fill is required for the site grading, engineered fill suitable for normal construction can be considered. Soil pressures of 100 kPa (SLS) and 160 kPa (ULS) are recommended for footings founded on engineered fill. The fill must be certified by the geotechnical consultant that supervised and inspected the fill placement. Details of engineered fill are provided in Section 6.1 of this report.

The total and differential settlements of footings designed for the recommended bearing pressure at SLS are estimated to be 25 mm and 20 mm, respectively.

One must be aware that the recommended soil bearing pressures are given as a guide for foundation design. The bearing subsoil must be confirmed by subgrade inspection performed by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the revealed conditions are compatible with the foundation design requirements.

Footings exposed to weathering, or in unheated areas, should have at least 1.2 m of earth cover for protection against frost action.

If groundwater seepage is encountered during the footing excavations, or where the subgrade is found to be wet, the footings must be poured immediately after subgrade inspection or the subgrade should be protected by a concrete mud-slab immediately after exposure. This will prevent construction disturbance and costly rectification of the bearing subsoil.

The foundations should meet the requirements specified in the latest Ontario Building Code, and the structure should be designed to resist an earthquake force using Site Classification 'D' (stiff soil).

6.3 Basement and Slab-On-Grade Construction

Perimeter walls of basement should be designed to sustain a lateral earth pressure calculated using the soil parameters given in Table 4 in this report. Any applicable surcharge loads beside the basement must also be included in the design of the basement.

Perimeter subdrains and dampproofing of the foundation walls will be required in order to provide a dry basement. All the subdrains should be encased in a fabric filter to protect them against blockage by silting.

Where groundwater seepage is encountered during the basement excavation, floor subdrains may be required. This can be further assessed during construction.

The on site subsoils consist of clay and silts with high soil-adfreezing potential. The foundation walls should be backfilled with non-frost susceptible granular material or provided with a slip membrane.

The subgrade for the basement slab and other slab-on-grade must consist of sound natural soils or properly compacted inorganic fill. In preparation of the subgrade, any topsoil should be removed. The earth fill and weathered soil should be subexcavated, sorted free of any deleterious material, aerated and uniformly compacted to 98% or + of its maximum SPDD. In addition, any new fill should consist of organic-free soil, compacted uniformly to 98% or + of its maximum SPDD. The final subgrade must be inspected and assessed by proof-rolling prior to placement of granular bedding.

The basement/floor slab should be constructed on a granular bedding of 20 cm in thickness, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to 100% of its maximum SPDD.

A Modulus of Subgrade Reaction of 20 MPa/m is recommended for the slab-on-grade design.

The grading around the building structures must be such that it directs runoff away from the structures.

6.4 **Underground Services**

The subgrade for the underground services should consist of sound natural soils or properly compacted organic-free earth fill. Where topsoil, organic earth fill or badly weathered soil is encountered, it should be subexcavated and replaced with properly compacted inorganic soil and/or bedding material compacted to at least 98% or + SPDD.

A Class ‘B’ bedding is recommended for the underground services construction. The bedding material should consist of compacted 20-mm Crusher-Run Limestone, or equivalent. The pipe joints should be leak-proof, or the joints should be wrapped with a waterproof membrane, to prevent subgrade upfiltration through the joints. Where saturated soils are contacted at the pipe invert or extensive dewatering is required, a Class ‘A’ concrete bedding will be required.

In order to prevent pipe floatation when the sewer trench is deluged with water, a soil cover of at least two times the diameter of the pipe should be in place at all times after completion of the pipe installation.

Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

The subgrade of underground services may have moderately high corrosivity to metal pipes and fittings; therefore, the underground services should be protected against soil corrosion. For estimation for the anode weight requirements, the estimated electrical resistivity given for the disclosed soil can be used. This, however, should be confirmed by testing the soil along the service alignment at the time of construction.

6.5 Backfilling in Trenches and Excavated Areas

The on site inorganic soils are generally suitable for use as trench backfill. However, the backfill soils should be sorted free of any topsoil inclusions and other deleterious materials prior to the backfilling.

The backfill in trenches and excavated areas should be compacted to at least 95% of its maximum SPDD and increased to 98% or + SPDD below the floor slab. In the zone within 1.0 m below the pavement subgrade, the materials should be compacted with the water content 2% to 3% drier than the optimum, and the compaction should be increased to at least 98% of the respective maximum SPDD. This is to provide the required stiffness for pavement construction. In the lower zone, the compaction should be carried out on the wet side of the optimum; this allows a wider latitude of lift thickness.

In normal underground services construction practice, the problem areas of settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns. In areas which are inaccessible to a heavy compactor, imported sand backfill should be used.

Unless compaction of the backfill is carefully performed, the interface of the native soils and the sand backfill will have to be flooded for a period of several days.

Narrow trenches for services crossings should be cut at 2H:1V, or flatter, so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement of proper compaction. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

One must be aware of the possible consequences during trench backfilling and exercise caution as described below:

- When construction is carried out in freezing winter weather, allowance should be made for these following conditions. Despite stringent backfill monitoring, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in situ soils have a water content on the dry side of the optimum, it would be impossible to wet the soils due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction. Furthermore, the freezing condition will prevent flooding of the backfill when it is required, such as in a narrow vertical trench section, or when the trench box is removed. The above will invariably cause backfill settlement that may become evident within 1 to several years, depending on the depth of the trench which has been backfilled.
- In areas where the construction is carried out during the winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement and the slab-on-grade construction.
- In deep trench backfill, one must be aware that future settlement may occur, unless the side of the cut is flattened to at least 2H:1V, and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 95% of the maximum SPDD, with the moisture content on the wet side of the optimum.
- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand and the compaction must be carried out diligently prior to the placement of the backfill above this sector; i.e., in the upper sloped trench section. This measure is necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section.
- In areas where groundwater movement is expected in the sand fill mantle, anti-seepage collars should be provided, unless concrete bedding is used in the service trenches.

6.6 Driveways, Sidewalks, Interlocking Stone Pavement and Landscaping

Due to the high frost susceptibility of the underlying soils, excessive movement of the pavement structure and sidewalk can be expected during the freeze and thaw seasons.

Interlocking stone pavement, sidewalks and landscaping structures in areas which are sensitive to frost-induced ground movement must be constructed on a free-draining, non-frost-susceptible granular material such as Granular 'B'. The material must extend to 0.3 to 1.2 m below the sidewalk, slab or pavement surface, depending on the degree of tolerance for movement, and be provided with positive drainage, such as weeper subdrains connected to manholes or catch basins. Alternatively, the landscaping structures, sidewalks and interlocking stone pavement should be properly insulated with 50-mm Styrofoam, or equivalent.

6.7 Pavement Design

The recommended pavement design for local roads, meeting the Town of Aurora specifications, is presented in Table 3.

Table 3 - Pavement Design - Local Road

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	50	HL-8
Granular Base	150	20-mm Crusher-Run Limestone or equivalent
Granular Sub-base	300	50-mm Crusher-Run Limestone or equivalent

In preparation of the subgrade, topsoil should be removed and the subgrade surface must be proof-rolled. The earth fill, weathered soil or soft/loose subgrade must be subexcavated, sorted free of any deleterious materials, aerated and properly compacted. New fill used to raise the grade for pavement construction should consist of uniformly compacted organic-free soil. In the zone within 1.0 m below the pavement subgrade, the fill should be compacted to at least 98% of its maximum SPDD, with the water content 2% to 3% drier than the optimum. In the lower zone, a 95% or + Standard Proctor compaction is considered adequate.

All the granular bases should be compacted to 100% of their maximum SPDD.

The road subgrade will suffer a strength regression if water is allowed to saturate the mantle. The following measures should, therefore, be incorporated into the construction procedures and pavement design:

- Areas adjacent to the road should be properly graded to prevent ponding of large amounts of water during the interim construction period.
- Curb subdrains will be required. The subdrains should consist of filter-sleeved weepers to prevent blockage by silting.

- If the road construction does not immediately follow the trench backfilling, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- If the road is to be constructed during wet seasons and extensively soft subgrade occurs, the granular sub-base should be thickened in order to compensate for the inadequate strength of the subgrade. This can be assessed during construction.

6.8 Soil Parameters

The recommended soil parameters for the project design are given in Table 4.

Table 4 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**		**Estimated Bulk Factor**	
	Bulk	**Submerged**	**Loose**	**Compacted**
Earth Fill	20.5	11.5	1.20	0.98
Silty Clay	20.5	11.5	1.30	1.00
Silt/Sandy Silt/Silty Fine Sand	21.0	11.0	1.20	1.00
Sand	20.0	10.8	1.25	0.98
Silty Sand Till	22.5	12.5	1.30	1.03
Lateral Earth Pressure Coefficients		**Active K_a**	**At Rest K_0**	**Passive K_p**
Earth Fill and Silty Clay		0.40	0.50	2.50
Silts/Sands/Silty Sand Till		0.33	0.48	3.00
Maximum Allowable Soil Pressure (SLS) for Thrust Block Design				
Sound Natural Soils and Engineered Fill				50 kPa
Coefficients of Friction				
Between Concrete and Granular Base				0.50
Between Concrete and Sound Natural Soils				0.35

6.9 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 5.

Table 5 - Classification of Soils for Excavation

Material	Type
Stiff to very stiff Clay and sound Till	2
Earth Fill, weathered Soils, firm Clay and dewatered Silts and Sands	3
Saturated Silts and Sands	4

Excavation into the till containing boulders may require extra effort and the use of a heavy-duty excavator. Boulders larger than 15 cm in size are not suitable for structural backfill and/or construction of engineered fill.

In excavation, groundwater yield from the silty clay is expected to be slow in rate and limited in quantity due to its low permeability, while the yield from the silts, sands and silty sand till may be moderate to appreciable, and likely persistent.

Where excavation is to be carried out in the wet or water-bearing silts or sands, the possibility of flowing sides and bottom boiling dictates that the ground be predrained by pumping from closely spaced sump-wells or, if necessary, the use of a well-point dewatering system. This should be assessed by test pumping prior to the project construction when the intended bottom of excavation is determined. In order to provide a stable subgrade for the services or foundation construction, the groundwater should be depressed at least 1.0 m below the subgrade level. The need for dewatering should be further assessed by a hydrogeologist.

Alternatively, sheeting structures can be installed around the excavation. The sheeting structure should be driven to a depth below the bottom of the excavation at least equal to the height of water above the bed of excavation. The sheeting structure must be properly designed by a qualified structural engineer to sustain the earth pressure, hydrostatic pressure and applicable surcharge loads.

Prospective contractors must be asked to assess the in situ subsurface conditions for soil cuts by digging test pits to at least 0.5 m below the intended bottom of excavation. These test pits should be allowed to remain open for a period of at least 4 hours to assess the trenching conditions.

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the accounts of Shining Hill Estates Operator Inc., and for review by the designated consultants and government agencies. Use of the report is subject to the conditions and limitations of the contractual agreement.

The material in the report reflects the judgement of Mumta Mistry, B.A.Sc., and Bernard Lee, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

Mumta Mistry, B.A.Sc.

Bernard Lee, P.Eng.
MM/BL:dd

LICENSED PROFESSIONAL ENGINEER
Jan 13, 2021
B. P. Y. LEE
100104568
PROVINCE OF ONTARIO

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

☐ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres

1lb = 0.454 kg

1 inch = 25.4 mm

1ksf = 47.88 kPa

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 201

FIGURE NO.: 1

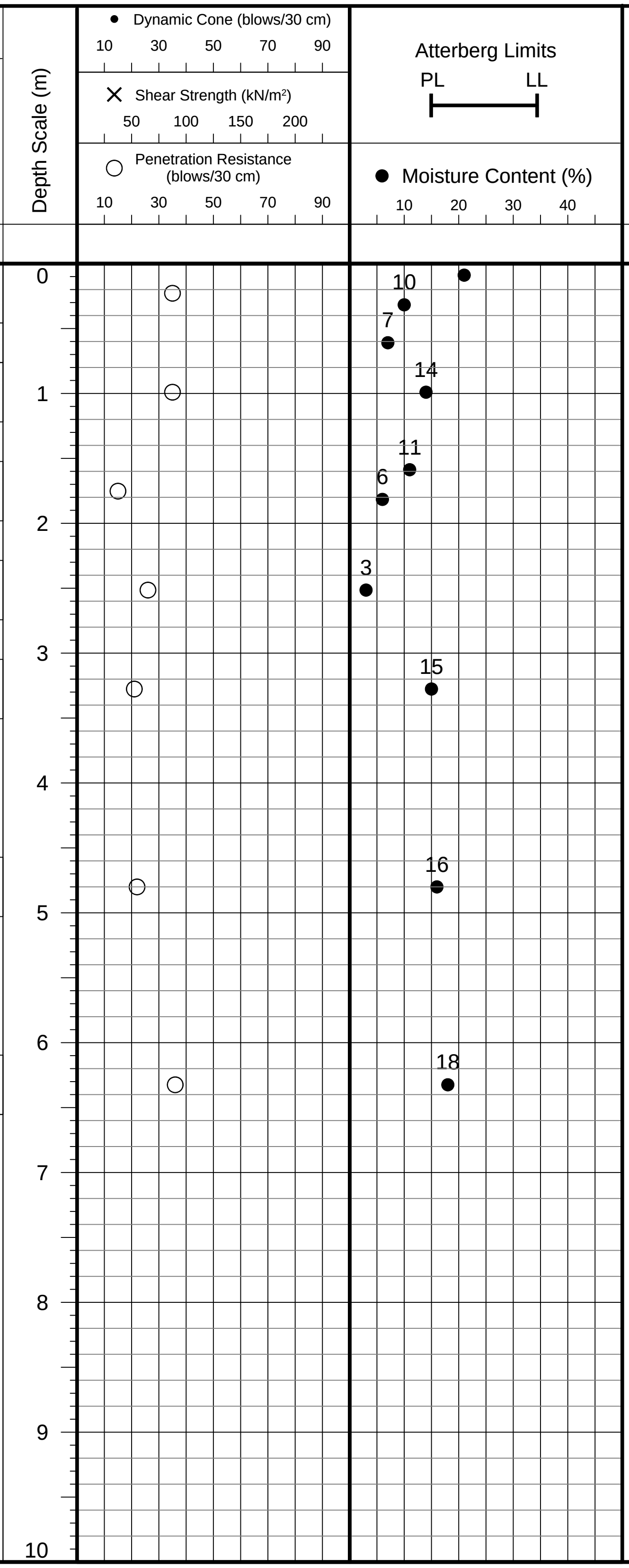
PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 15, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
271.9	Ground Surface			
0.0	**18 cm TOPSOIL**	1A	DO	35
	Brown **EARTH FILL** **(Silty Sand)** a trace of clay, some gravel	1B		
		2	AS	-
271.1 0.8	Brown, hard **SILTY CLAY** a trace of sand with silt layers, and occ. gravel	3	DO	35
270.4 1.5	sandy silt layer	4A	DO	15
	Brown, compact **SAND** fine grained a trace to some silt	4B		
		5	DO	26
268.9 3.0	Brown, compact to dense **SANDY SILT** a trace of clay	6	DO	21
		7	DO	22
		8	DO	36
265.3 6.6	**END OF BOREHOLE**			



WATER LEVEL

Cave-in @ El. 267.6 m on completion

Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 202

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed School Block

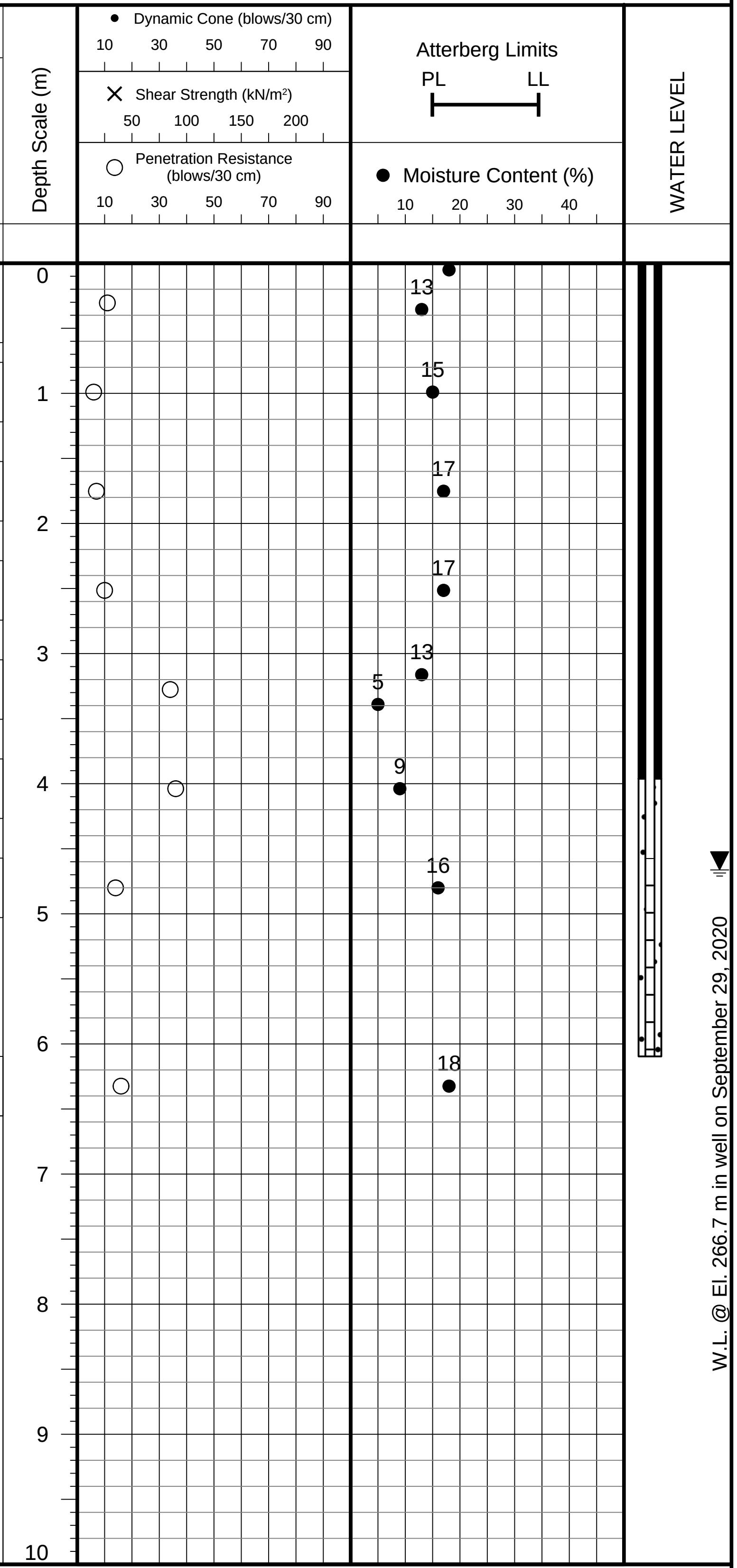
METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 16, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
271.3	Ground Surface			
0.0	**10 cm TOPSOIL**	1A		
	Brown **EARTH FILL** **(Silty Clay and Sandy Silt)**	1B	DO	11
	a trace of gravel organic inclusions	2	DO	6
		3	DO	7
	silty clay sandy silt topsoil inclusions	4	DO	10
268.0 3.3	Brown, dense **SAND** fine to medium grained a trace to some silt	5A 5B	DO	34
		6	DO	36
266.7 4.6	Brown, compact **SILTY FINE SAND** a trace of clay	7	DO	14
265.2 6.1	Brown, compact **SILT** traces of clay and sand	8	DO	16
264.7 6.6	**END OF BOREHOLE**			

Installed 50 mm Ø PVC monitoring well to 6.1 m (1.5 m screen)
Sand backfill from 4.0 m to 6.1 m
Bentonite holeplug from 0 m to 4.0 m
Provided with a 4x4 steel monument casing with top and bottom caps, and lock



Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 203

FIGURE NO.: 3

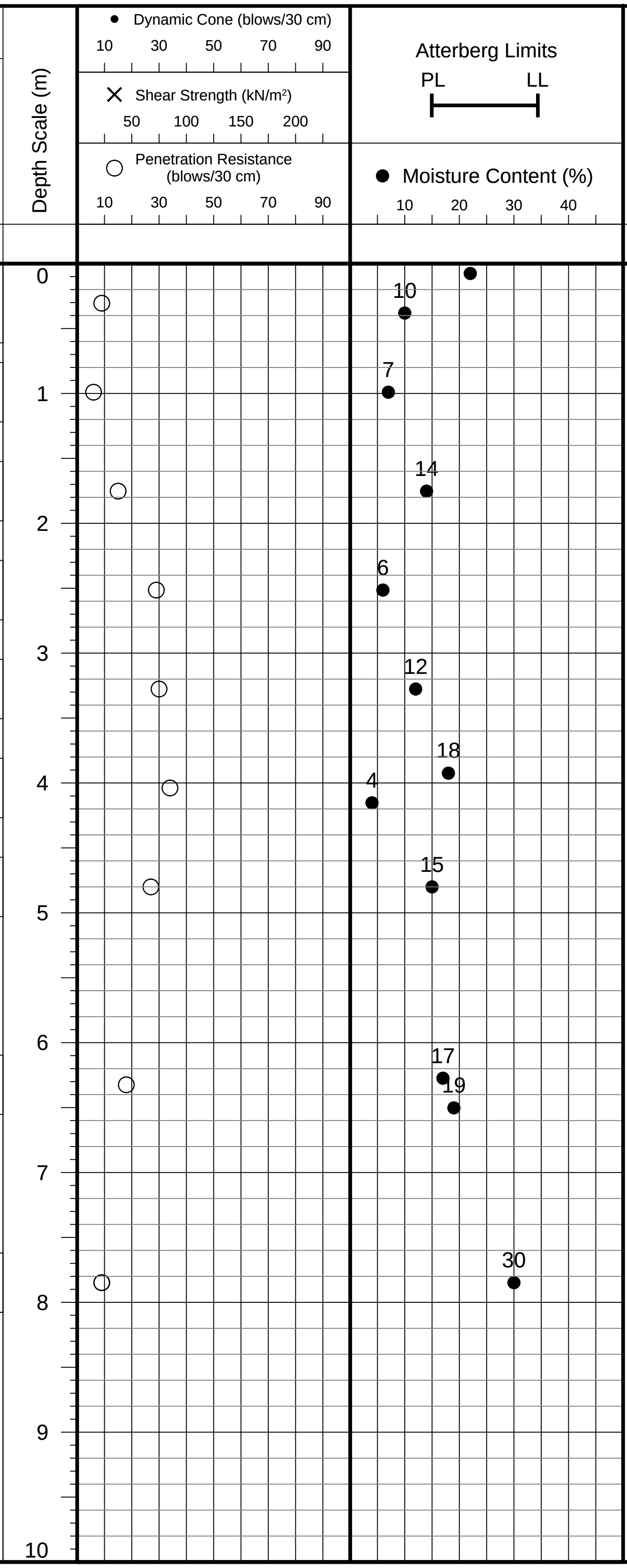
PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 16, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
272.4	Ground Surface			
0.0	**15 cm TOPSOIL**	1A		
	Brown **EARTH FILL** **(Silty Sand)** a trace of clay	1B	DO	9
		2	DO	6
	organic inclusions	3	DO	15
270.1 2.3	Brown, compact **SILTY SAND TILL** a trace of clay a trace to some gravel occ. sand seams and layers, cobbles and boulders	4	DO	29
		5	DO	30
		6A	DO	34
268.4 4.0	Brown, compact to dense **SAND** fine to coarse grained a trace of silt	6B		
		7	DO	27
267.5 4.9	Brown, compact **SANDY SILT** a trace of clay	8A	DO	18
265.9 6.5	Stiff **SILTY CLAY** a trace of sand	8B		
	brown grey	9	DO	9
264.3 8.1	**END OF BOREHOLE**			



WATER LEVEL

Cave-in @ El. 267.2 m on completion

Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 204

FIGURE NO.: 4

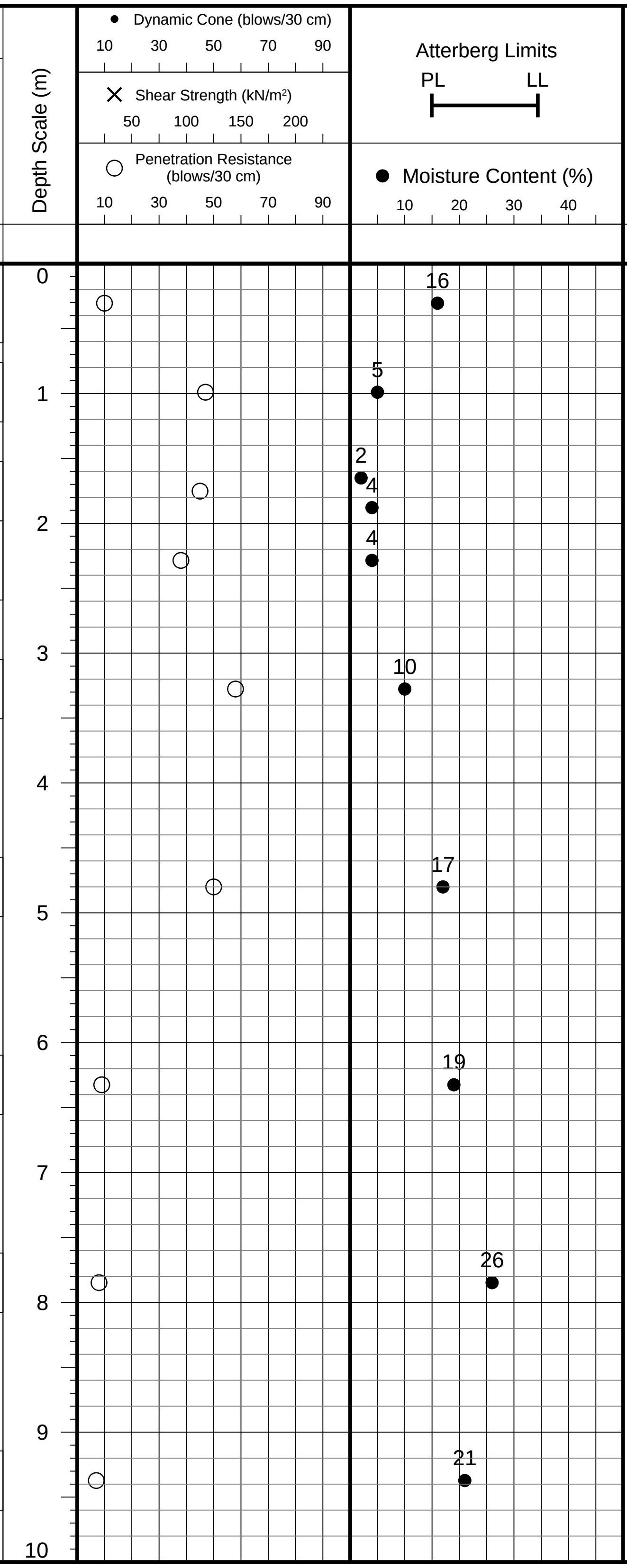
PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Hollow Stem Augers and Washbore with Tri-Cone

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 17 to 21, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
272.6	Ground Surface			
0.0	**TOPSOIL FILL**	1	DO	10
271.8 0.8	Brown, dense to very dense **SAND** fine and fine to medium grained a trace of silt	2	DO	47
	gravelly	3A 3B	DO	45
		4	DO	38
	silt layers	5	DO	58
268.0 4.6	Brown, dense **SANDY SILT** a trace of clay	6	DO	50
266.5 6.1	Grey, firm to stiff **SILTY CLAY** **(varved)** a trace of sand with silt layers occ. gravel	7	DO	9
		8	DO	8
		9	DO	7
262.6	*(Continued on next page)*			



WATER LEVEL

No W.L. recorded due to process of washboring to carry out deep borehole

Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 204

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Hollow Stem Augers and Washbore with Tri-Cone

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 17 to 21, 2020

El. (m)
Depth (m)

10.0

SOIL DESCRIPTION

(Continued)
Grey, firm

SILTY CLAY
(varved)

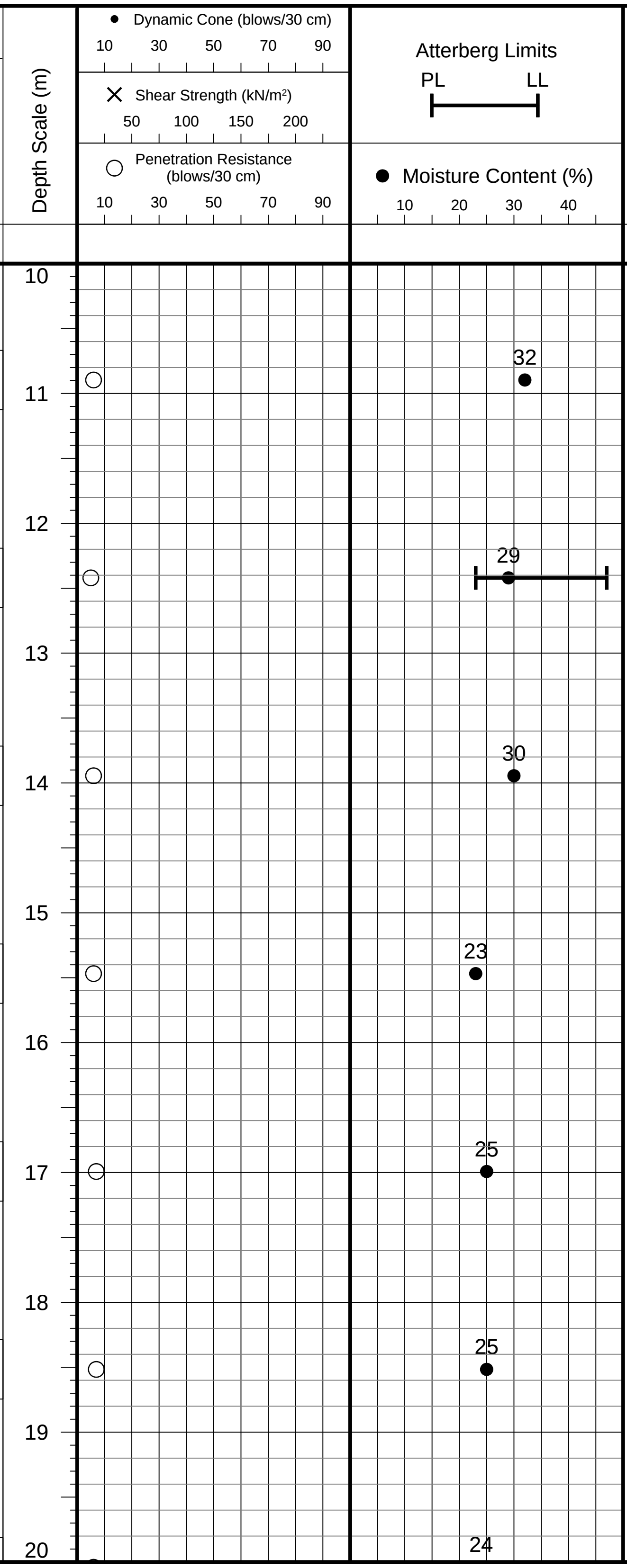
a trace of sand
with silt layers
occ. gravel

silty clay till layer

252.6

(Continued on next page)

SAMPLES			
Number	Type	N-Value	Depth Scale (m)
10	DO	6	11
11	DO	5	12.4
12	DO	6	14
13	DO	6	15.5
14	DO	7	17
15	DO	7	18.5



WATER LEVEL

Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 204

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed School Block

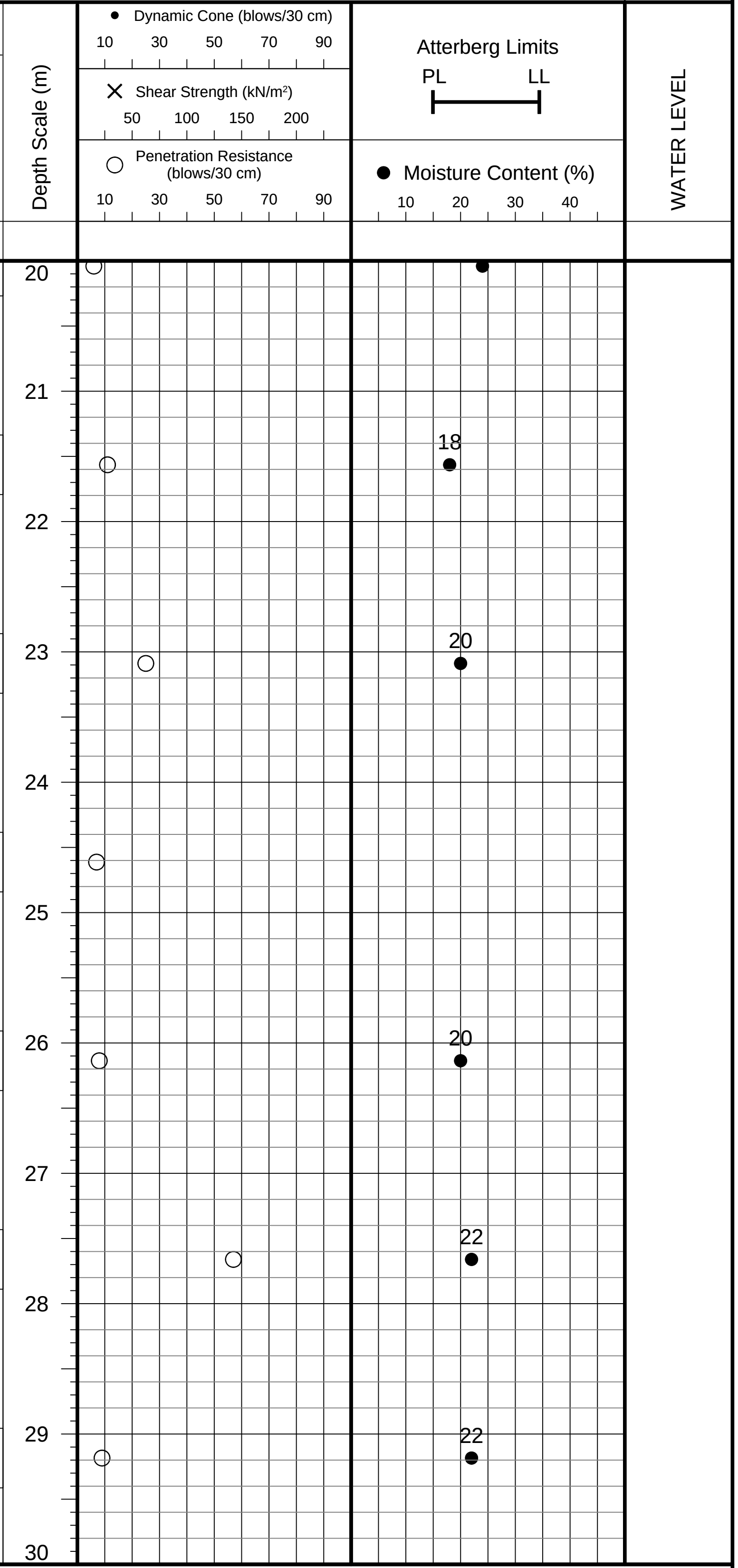
METHOD OF BORING: Hollow Stem Augers and Washbore with Tri-Cone

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 17 to 21, 2020

El. (m) Depth (m)	SOIL DESCRIPTION
20.0	*(Continued)* Grey, firm to hard **SILTY CLAY (varved)** a trace of sand with silt layers occ. gravel
242.6	*(Continued on next page)*

SAMPLES Number	Type	N-Value
16	DO	6
17	DO	11
18	DO	25
19	DO	7
20	DO	8
21	DO	57
22	DO	9



Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 204

FIGURE NO.: 4

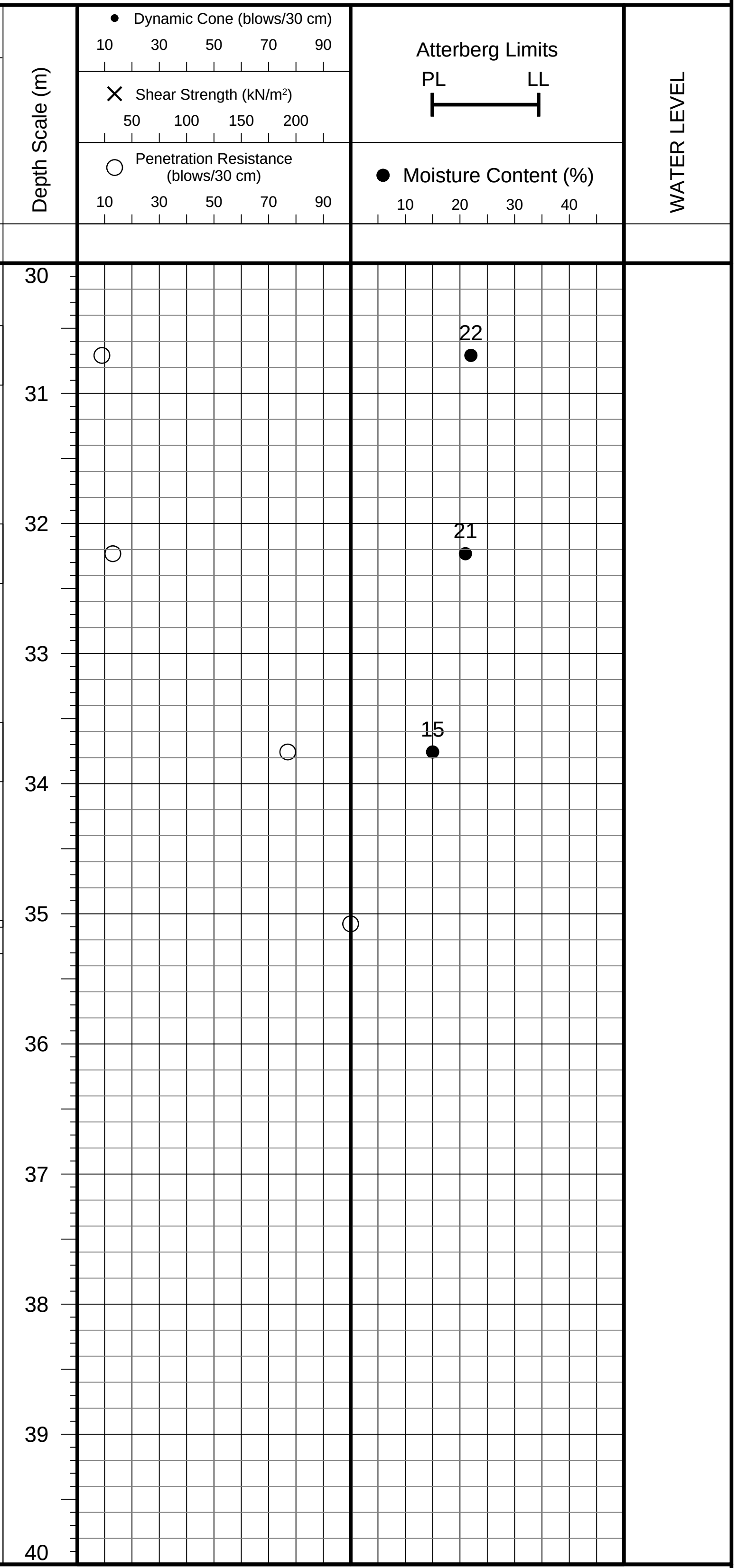
PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Hollow Stem Augers and Washbore with Tri-Cone

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 17 to 21, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
30.0	*(Continued)* Grey, stiff to hard **SILTY CLAY (varved)** a trace to some sand with silt layers occ. gravel			
		23	DO	9
	silty clay till layer	24	DO	13
		25	DO	77
	cobbles/boulders/ hard augering/ spoon bouncing	~~26~~	~~DO~~	~~50/5~~
237.3 35.3	**END OF BOREHOLE (Refusal to Auger)**			



Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 205

FIGURE NO.: 5

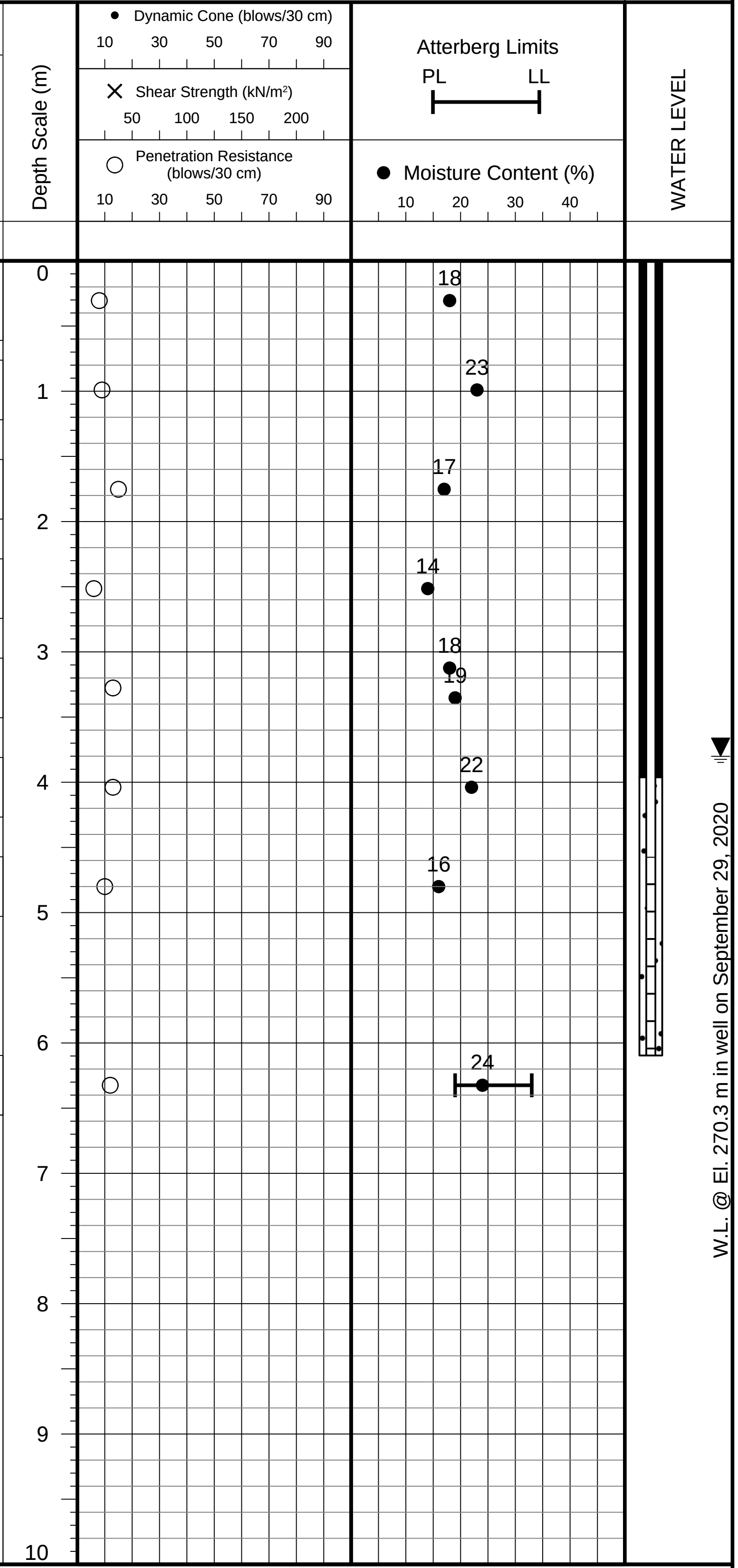
PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION:
Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 17, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
274.1	Ground Surface			
0.0	Brown **EARTH FILL** **(Topsoil, Silty Clay and Silt)** a trace to some sand	1	DO	8
		2	DO	9
	topsoil/silty clay mix silty clay	3	DO	15
	silt	4	DO	6
	topsoil inclusions	5A		
270.9 3.2	Brown, loose to compact **SILT** a traces to some clay a trace of sand occ. gravel	5B	DO	13
		6	DO	13
		7	DO	10
269.1 5.0	Grey, very stiff **SILTY CLAY** some sand occ. gravel			
		8	DO	12
267.5 6.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 6.1 m (1.5 m screen) Sand backfill from 4.0 m to 6.1 m Bentonite holeplug from 0 m to 4.0 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 206D

FIGURE NO.: 6A

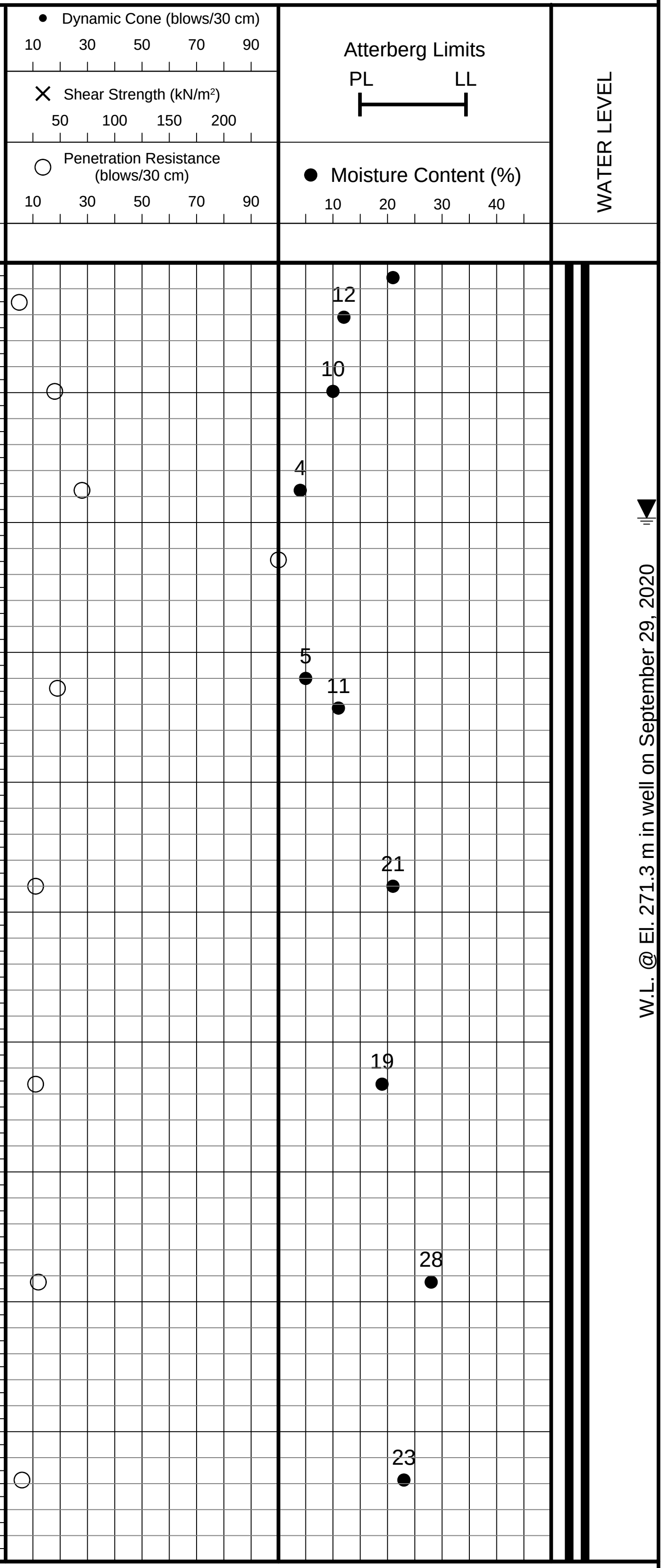
PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Hollow Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 16 to 17, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
273.3	Ground Surface				
0.0	**23 cm TOPSOIL**	1A	DO	5	0
	Brown, loose to very dense **SAND** fine and fine to medium grained a trace to some silt	1B			
	weathered	2	DO	18	1
	fine grained	3	DO	28	
	hard augering/ gravelly/ cobbles and boulders	4	DO	50/0	2
	fine to medium grained	5A	DO	19	3
270.0 3.3	Firm to very stiff **SILTY CLAY (varved)** a trace of sand with sand and silt seams and layers	5B			
	silty clay till layer/ brown grey	6	DO	11	4
		7	DO	11	6
		8	DO	12	7
		9	DO	6	9
263.3	*(Continued on next page)*				10



Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 206D

FIGURE NO.: 6A

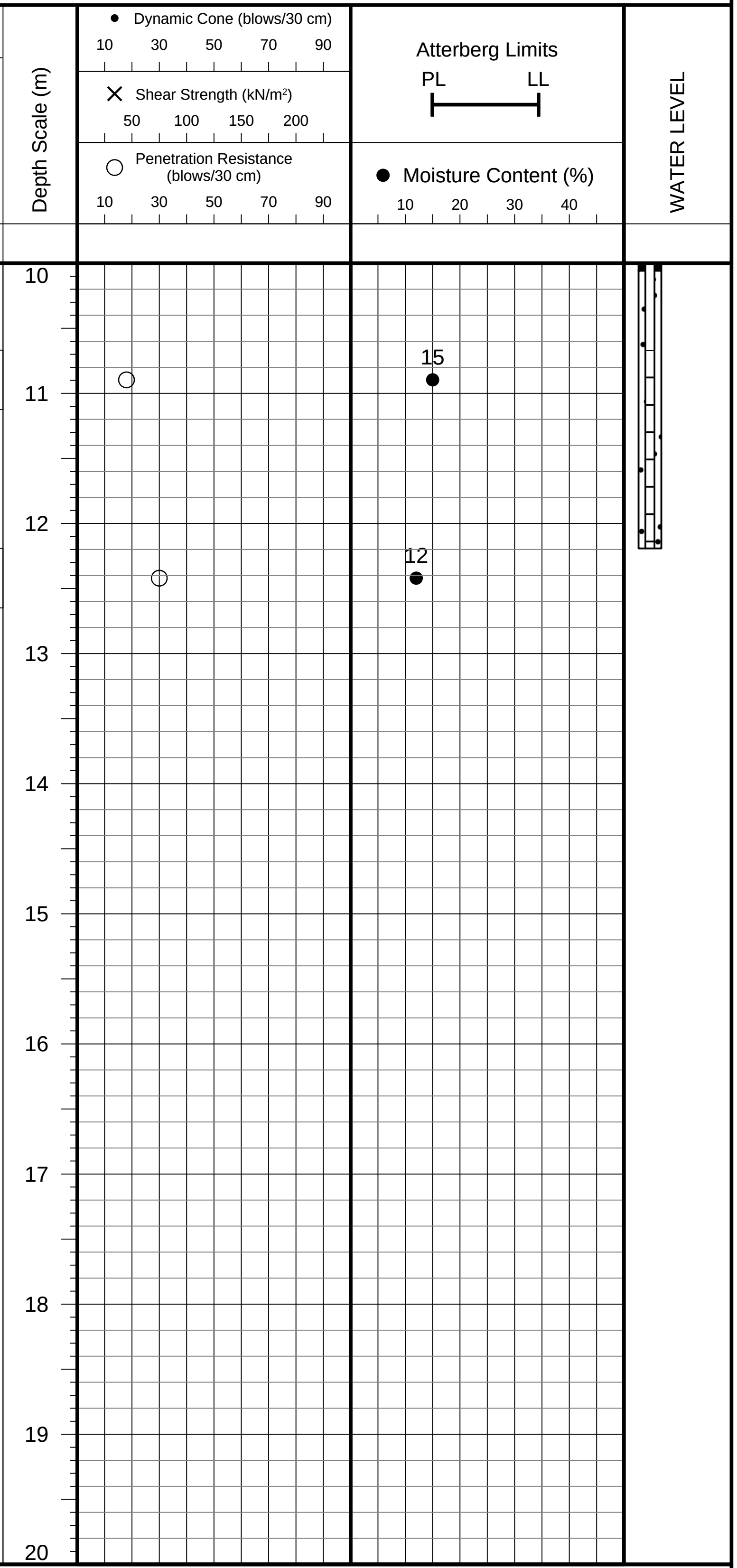
PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Hollow Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 16 to 17, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
10.0	*(Continued)* Grey, very stiff **SILTY CLAY (varved)** a trace to some sand with silt layers occ. gravel			
		10	DO	18
	sandy silt till layer			
		11	DO	30
260.7 12.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 12.2 m (1.5 m screen) Sand backfill from 10.1 m to 12.2 m Bentonite holeplug from 0 m to 10.1 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



Soil Engineers Ltd.

JOB NO.: 2008-S135B

LOG OF BOREHOLE NO.: 206S

FIGURE NO.: 6B

PROJECT DESCRIPTION: Proposed School Block

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
306 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 17, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	 Type	 N-Value
273.3	Ground Surface			
0.0	**STRAIGHT AUGERING FOR INSTALLATION OF NESTED WELL**			
265.7 7.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 7.6 m (1.5 m screen) Sand backfill from 5.5 m to 7.6 m Bentonite holeplug from 0 m to 5.5 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			

Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10

● Dynamic Cone (blows/30 cm): 10 30 50 70 90

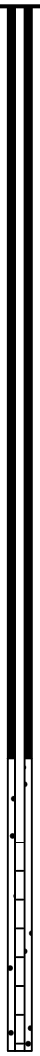
× Shear Strength (kN/m²): 50 100 150 200

○ Penetration Resistance (blows/30 cm): 10 30 50 70 90

Atterberg Limits PL LL

● Moisture Content (%): 10 20 30 40

WATER LEVEL



▼ W.L. @ El. 269.4 m in well on September 29, 2020

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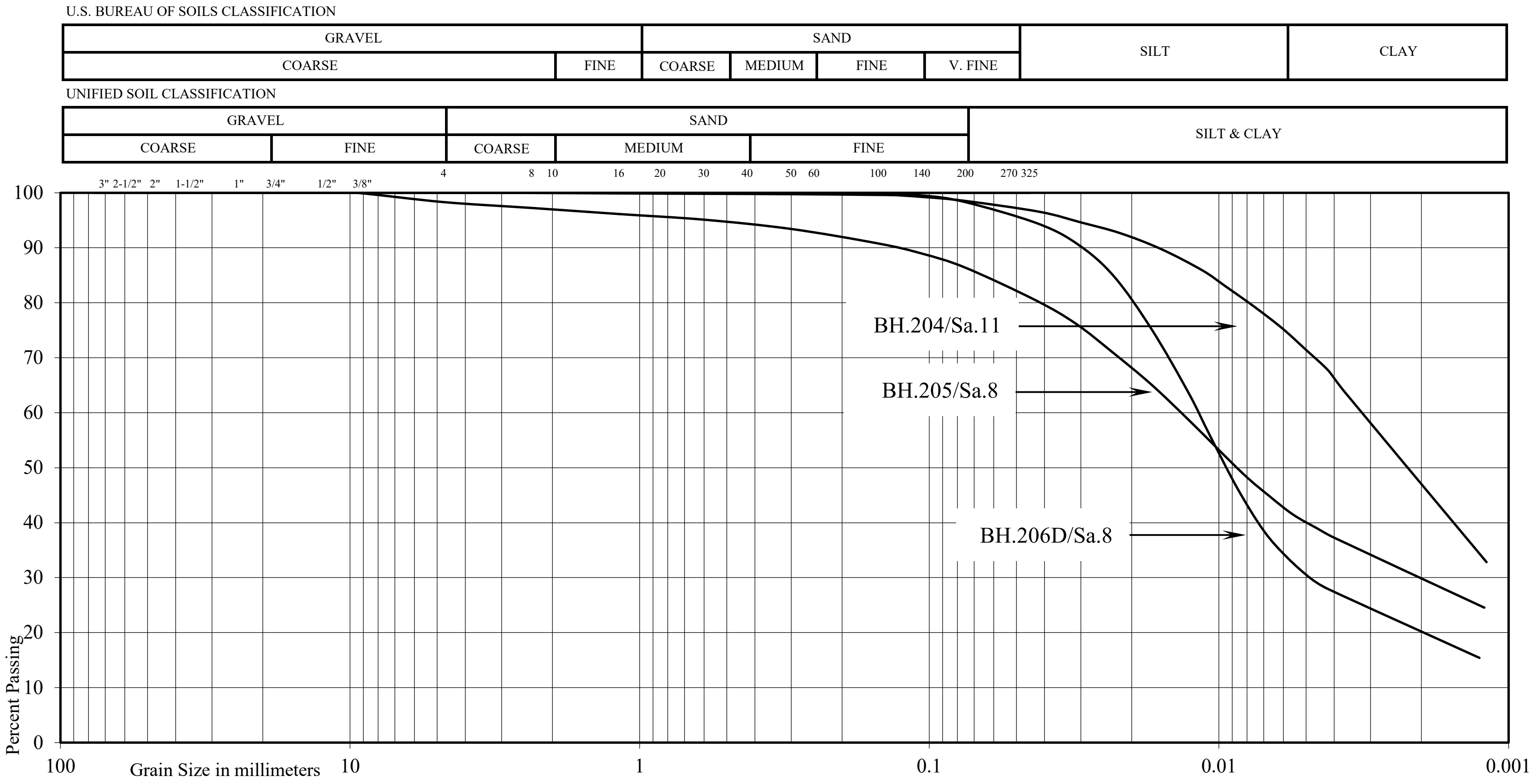
GRAIN SIZE DISTRIBUTION

Reference No: 2008-S135 (B)



Project:	Proposed School Block		
Location:	Shinning Hill Phase 3		
	306 St. John's Sideroad, Town of Aurora		
Borehole No:	204	205	206D
Sample No:	11	8	8
Depth (m):	12.4	6.3	7.9
Elevation (m):	260.2	267.8	265.4

BH./Sa.	204/11	205/8	206D/8
Liquid Limit (%) =	47	33	-
Plastic Limit (%) =	23	19	-
Plasticity Index (%) =	24	14	-
Moisture Content (%) =	29	24	28
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}

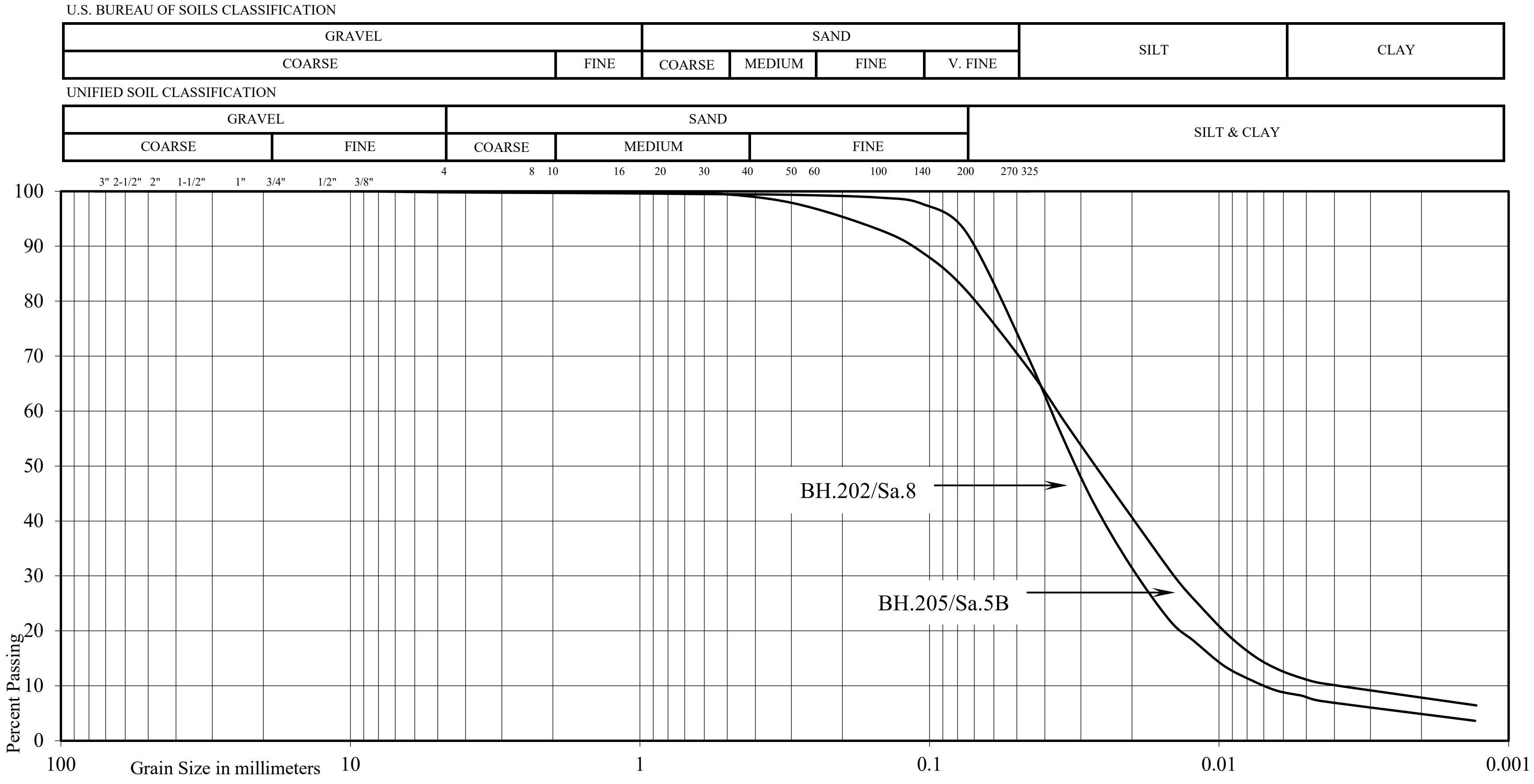
Classification of Sample [& Group Symbol]: SILTY CLAY, a trace to some sand, occasional gravel

Figure: 7

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 2008-S135 (B)



Project: Proposed School Block

Location: Shinning Hill Phase 3

306 St. John's Sideroad, Town of Aurora

Borehole No:	202	205
Sample No:	8	5B
Depth (m):	6.3	3.4
Elevation (m):	265.0	270.7

BH./Sa.	202/8	205/5B
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	18	19
Estimated Permeability (cm./sec.) =	10^{-4}	10^{-5}

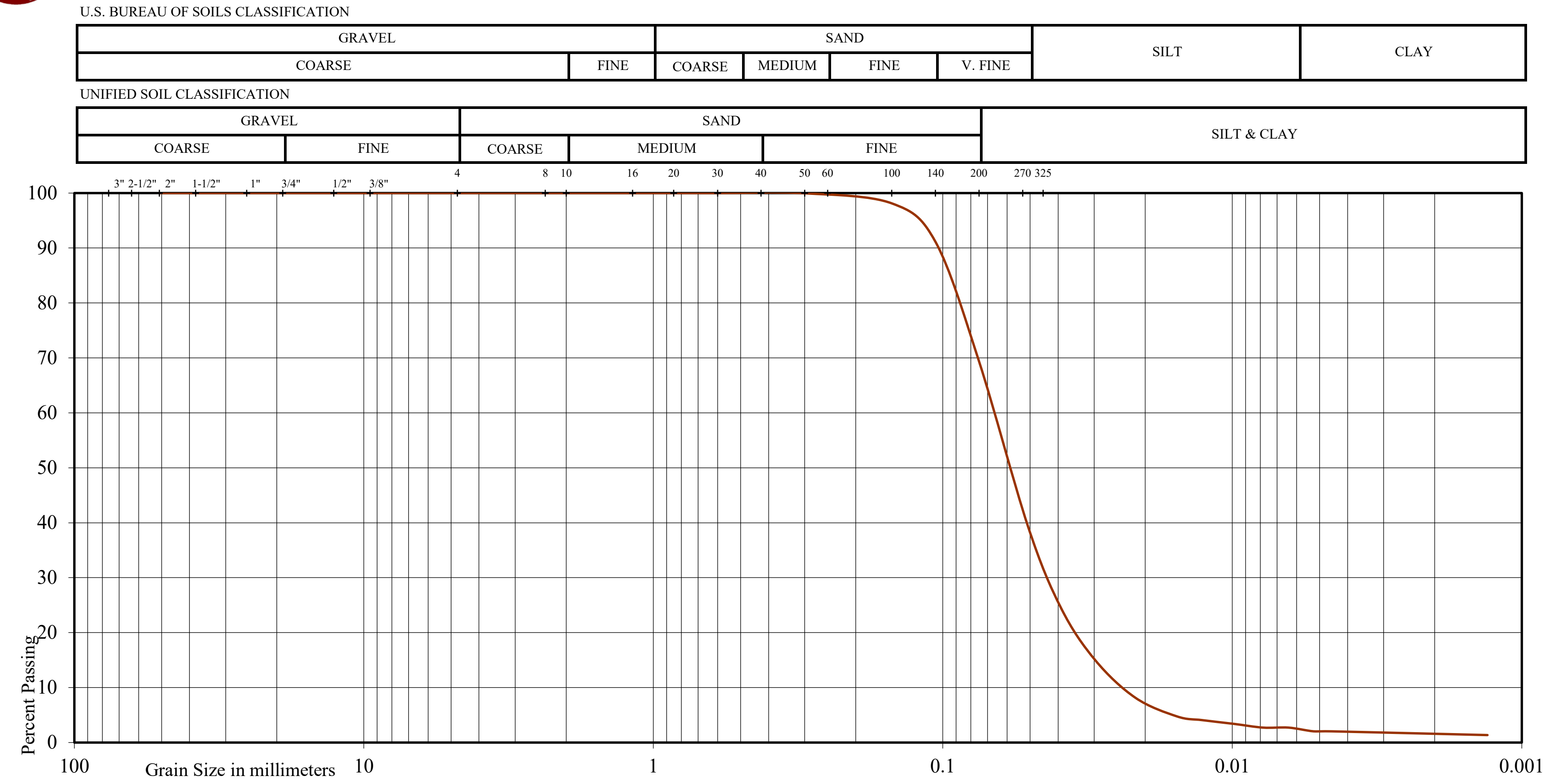
Classification of Sample [& Group Symbol]: SILT, a trace of clay, a trace to some sand

Figure: 8

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 2008-S135 (B)



Project: Proposed School Block

Location: Shinning Hill Phase 3

306 St. John's Sideroad, Town of Aurora

Borehole No: 201

Sample No: 6

Depth (m): 3.3

Elevation (m): 268.6

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

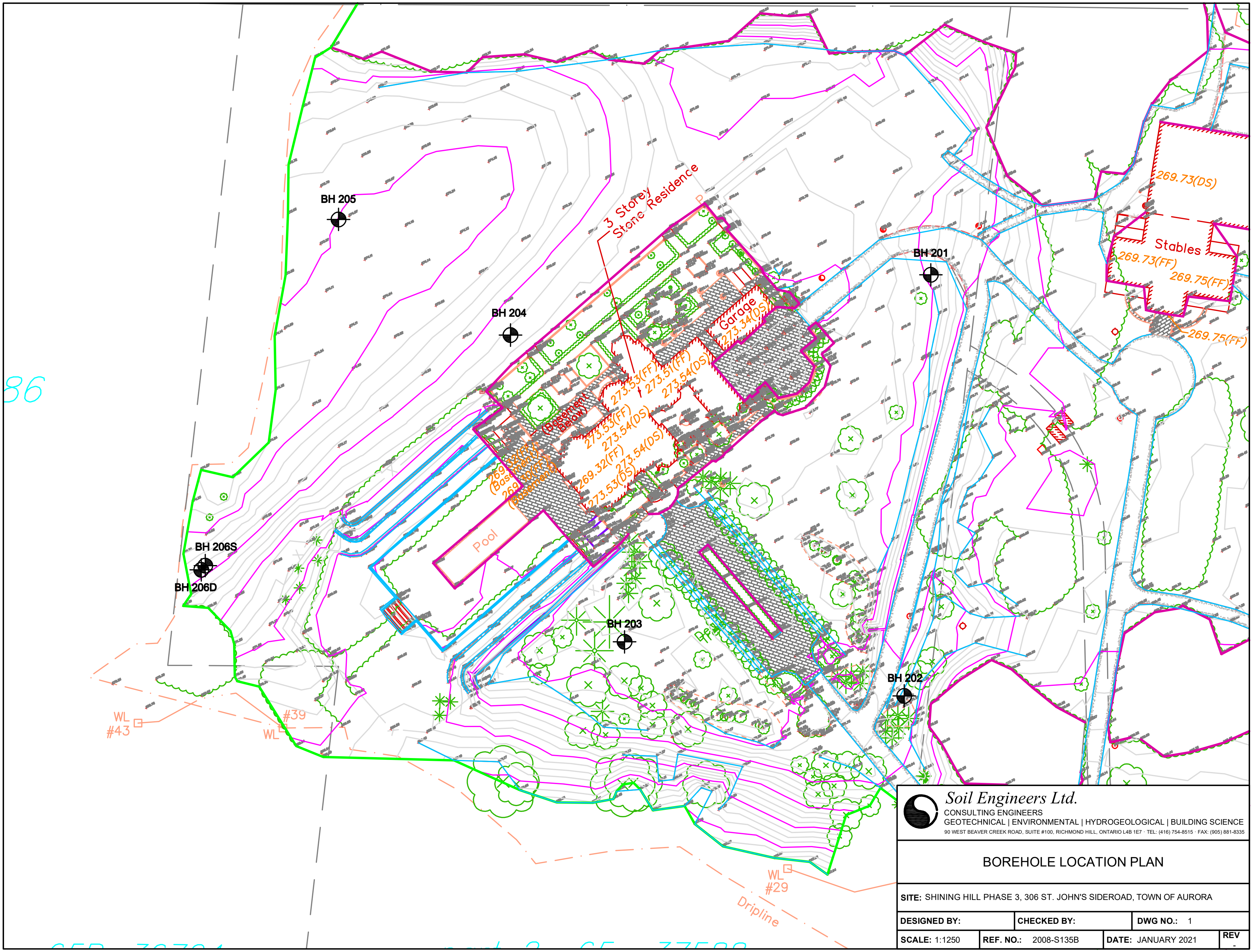
Moisture Content (%) = 15

Estimated Permeability

(cm./sec.) = 10^{-3}

Classification of Sample [& Group Symbol]: SANDY SILT, a trace of clay

Figure: 9



Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

BOREHOLE LOCATION PLAN

SITE: SHINING HILL PHASE 3, 306 ST. JOHN'S SIDEROAD, TOWN OF AURORA

DESIGNED BY:
CHECKED BY:
DWG NO.: 1
SCALE: 1:1250
REF. NO.: 2008-S135B
DATE: JANUARY 2021
REV -

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SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.:	2008-S135B
REPORT DATE:	January 2021
PROJECT DESCRIPTION:	Proposed School Block
PROJECT LOCATION:	Shining Hill Phase 3 306 St. John's Sideroad Town of Aurora

LEGEND

▨	TOPSOIL	▨	SILTY FINE SAND	▨	SILT
▨	FILL	▨	SILTY SAND TILL	▨	SILTY CLAY
▨	SAND	▨	SANDY SILT		

CAVE-IN   ▼ WATER LEVEL (STABILIZED)